CURLEW

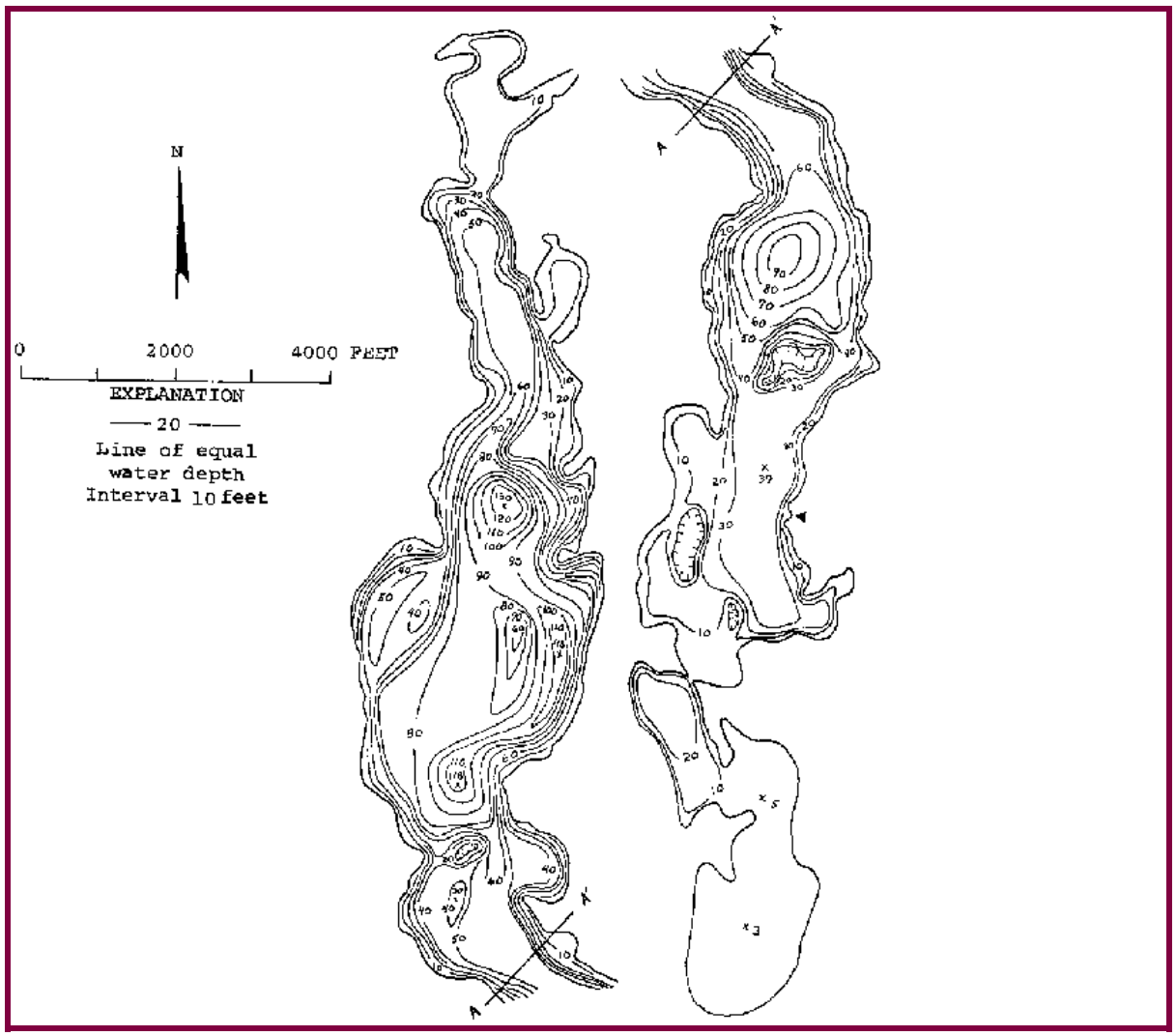
FERRY County

Lake ID: *CURFE1*

Ecoregion: 8

Curlew Lake is located 4.8 miles northeast of Republic. It is a natural lake, and water level fluctuations are stabilized by a three foot dam built in 1926. The lake extends northerly 4.8 miles to the outlet. There are four islands, totaling 20 acres, that are not included in the reported acreage. Inlets include Herron, Mires, Barrett, and Trout Creeks.

Area (acres)	*Maximum Depth (ft)*	*Mean Depth (ft)*	*Drainage (sq mi)*	
921	130	43	65	
Volume (ac-ft)	***Shoreline (miles)***	***Altitude (ft abv msl)***	***Latitude***	***Longitude***
39519	15.78	2333	48 46 03.	118 39 23.



Station Information

CURFE1

Primary Station	Station # 1	latitude: 48 44 52.0	longitude: 118 39 48.0
	Description:	Deep site: Center of basin north of Fisherman's Cove and Tiffany's Resorts.	
Secondary Station	Station # 2	latitude: 48 44 47.0	longitude: 118 40 05.0
	Description:	Deep spot just north of the first island south of site 1.	

Trophic State Assessment for 1999

CURLEW

Analyst: MAGGIE BELL-MCKINNON

TSI_Secchi:	[a]	37	J
TSI_Phos:		47	
TSI_Chl:		41	
Narrative TSI:	[b]	M	

Summary Comments:

The general water clarity of Curlew Lake was good in 1999. The Secchi depth readings ranged from 3.7 meters (12.0 feet) to 5.8 meters (19.0 feet) with a mean Secchi depth of 5.1meters (16.7 feet). For comparison, in 1998 the mean Secchi depth was 3.5 meters (11.5 feet).

Numerous geese and/or other waterfowl were observed on the lake by the volunteer monitor during her sampling visits made between May and October.

The chemistry data collected for Curlew Lake showed moderate to high phosphorus levels throughout the summer: 10.5 ug/L to 23.7 ug/L in the epilimnion and hypolimnetic readings of 116 ug/L to 228 ug/L. The chlorophyll levels showed low to moderate density of algae growing in the lake. These data indicate an elevated level of productivity in Curlew Lake.

Ecology staff made four site visits in 1999. Thermal stratification and low dissolved oxygen levels in the hypolimnion were noted during each of these visits.

Ecology staff conducted an aquatic plant survey on 7/28/1999. A wide variety of aquatic plants occur in the lake. Dominant species include Chara sp. (muskwort) and Potamogeton crispus (curly leaf pondweed). A number of other Potamogeton species were also observed as well as Myriophyllum sibiricum (northern watermilfoil), Ceratophyllum demersum (hornwort) and Elodea canadensis (common elodea).

Based on the Secchi depth data, and the phosphorus and chlorophyll levels, Curlew Lake is classified as mesotrophic.

The following is an assessment written by Ecology staff, Sarah O'Neal, to determine

the phosphorus criterion for
Curlew Lake:

Curlew Lake is a large, deep lake with a steep shoreline. Its location in a sizeable watershed increases its susceptibility to anthropogenic eutrophication. In fact, practices throughout the watershed appear to have lead to a decline in the water quality of the lake. While clarity remained exceptionally high, excessive nutrients led to dense plant and algae growth which occasionally interfered with the lake's uses. Frequent algae blooms occurred throughout the summer. The relatively large body size of algae species may explain good transparency in spite of high chlorophyll and phosphorus levels. Plants grew densely, which is unusual in lakes with steep sides and a consequently reduced littoral zone. Dense macrophytes led to herbicide applications in 1988 and 1989 to control particularly weedy species. By 1999, however, those species again dominated the lake. Washington State University studied nutrient sources in Curlew Lake. The study implicated faulty septic tanks, livestock grazing in the watershed, fertilizer application, excessive plants, waterfowl, precipitation, groundwater, surface runoff, and past timber practices in the problem. Findings from the watershed survey agreed with these results. High total phosphorus levels in the hypolimnion also indicated internal loading, in which phosphorus is released from sediments into the water column. This often occurs when dissolved oxygen is absent near the lake bottom, as clearly indicated by the Hydrolab profile data. Anoxia also often leads to hydrogen sulfide near the bottom of the lake, causing an offensive, "rotten-egg" smell about which residents complained.

The lake supported a wide variety of uses. Survey respondents indicated fishing as the primary activity, with relaxing and canoeing/kayaking as other important interests. However, site visits to the lake and surveys also revealed water-skiing, swimming, picnicking, hunting, and bird watching as popular activities. Survey respondents indicated a desire for clearer water, as well as boat speed limits. Coldwater fish composed the majority of Curlew’s fishery. WDFW primarily managed the lake for rainbow trout. About 200,000 rainbow trout were released each year. Sixty-thousand of those were released annually from a cooperative net pen on the lake. Approximately 40% of tagged rainbow trout released from the net pen returned, indicating an unusually good utilization of most fish. Trout prefer at least 4.5mg/L dissolved oxygen and water temperatures below 20 degrees Celsius, which limits their range in Curlew Lake to depths of six to sixteen feet during the summer. The dominance of smaller zooplankton suggested an ineffective amount of predators to suppress planktivore density. Tiger muskies were additionally stocked in the lake in an attempt to control an oversized northern pike minnow population. Known warmwater game species in the lake consisted only of largemouth bass.

While uses were supported for most of the year, there were two to three weeks annually during which quality was impaired enough to affect many lake activities. This generally resulted from particularly dense algae blooms. Consequently, we suggest implementation of appropriate best management practices throughout the watershed. We recommend a total phosphorus criterion of 20 ug/L, the action value

for Northern Rockies lower mesotrophic lakes. This criterion will likely be exceeded during some years. Ferry County may want to consider adopting boat speed limits in certain areas or during certain times of day.

Mean Secchi = 4.9m; Mean TP = 19.3 ug/L; Mean Chl = 2.8 ug/L

[a] TSI Qualifiers: B or W-Secchi Disk hit bottow or entered weeds; J-Estimate; N-Fewer than the required number of samples

[b] E=eutrophic, ME=mesoeutrophic, M=mesotrophic, OM=oligomesotrophic, O=oligotrophic

Chemistry Data

CURLEW

Date	Time	Strata	Tot P (ug/L	Tot N (mg/L)	TN:TP	Chloro-phyll (ug/L)	Fecal Col. Bacteria (#/100mL)	Hardness (mg/L)	Calcium (ug/L)	Turbidity (NTU)
Station 1										
6/17/1999		E	23.7	.35	15	3.5		116	32400	.6 J
		H	116	.535	5					
7/15/1999	0900	E	10.5	.369	35	1.93				.8
		H	135	.624	5					
8/12/1999	0900	E	16.3	.392	24	2.5				.6
		H	190	.634	3					
9/16/1999		E	22.2	.358	16	2.9				.6
		H	228	.691	3					
Station 2										
6/17/1999		E	22.9	.326	14	3.7				
7/15/1999	1000	E	13	.375	29	2.13				
8/12/1999	1015	E	14.4	.372	26	2.5				
9/16/1999		E	22	.397	18	3.1				

Strata: L=lake surface, E=epilimnion, H=hypolimnion; Qualifier: J=Estimate, U=Less than, G=Greater than.

Watershed Survey

CURLEW

Survey Date: 9/16/1999

Land Uses (1 = Primary, 2 = Secondary, etc.)

- [2] **Agriculture(commercial, not hobby)**
- [1] **Residential**
- [5] **Commercial, Industrial**
- [3] **Park, forest or natural**
- [4] **Major transportation**

Impervious surfaces (Roads and parking area): No Curbs

Observations (check mark denotes presence)

BMP's ☐

Odors ☐

Cattle ☐ **Ducks** ☑ **Geese** ☑

Fertilizers and weed killers appear to be used in residential or agriculture area ☑

Spotty fertilizer use, but most notably at state park.

Buffer zones around streams and wetlands ☐

Areas of cleared lakeshore vegetation.

Irrigation ☐

Survey Id: 1

Habitat Survey Summary Report

CURLEW

Data are averages of ***10*** **Stations Surveyed** **Date of Visit:** 7/28/1999

Vegetation Type (Avg. only of sites w/ vegetation present; 1=coniferous, 3=deciduous)

Canopy Layer Avg:	1.9	**Number of stations with canopy:**	9
Understory Avg:	2.7	**Number of stations with understory:**	10

Percent Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)

Canopy Layer:	**trees > 0.3 m DBH**	1.3
	trees< 0.3 m DBH	1.3
Understory:	**woody shrubs saplings**	2.4
	tall herbs, forbs grasses	0.8
Ground Cover:	**woody shrubs seedlings**	2.0
	herbs, forbs, grasses	2.6
	standing water or inundated veg	0.1
	barren or buildings	1.0
Substrate Type (within shoreline plot):	**bedrock**	0.0
	boulders	0.0
	cobble/gravel	0.7
	loose sand	0.2
	other fine soil/sediment	0.4
	vegetated	3.6
	other	0.0
Bank Features:	**angle (O:<30; 1: 30-75; 2:nr vertical)**	1.4
	vertical dist (M from wtrln to high wt):	0.2
	horiz. dist. (M from wtrln to high wt):	0.1

Human Influence (0 = absent, 1 = adjacent to or behind plot, 2 = present within plot)	
buildings	0.8
commercial	0.2
park facilities	0.3
docks/boats	0.8
walls, dikes, or revetments	0.1
litter, trash dump, or landfill	0.0
roads or railroad	1.0
row crops	0.0
pasture or hayfield	0.2
orchard	0.0
lawn	0.1
other	0.0

Physical Habitat Characteristics	
station depth (m; at 10 m from shore)	3.2

Bottom Substrate (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)	
bedrock	0.0
boulders	0.0
cobble	0.5
gravel	1.3
sand	1.3
silt	2.6
woody debris	0.8

Macrophyte Areal Coverage (0 = absent, 1 = <10%, 2 = 10-40%, 3 = 40-75%, 4 = >75%)	
submergent	2.6
emergent	0.4
floating	0.0
total weed cover	2.6
Do macrophytes extend lakeward (-1 = yes, 0 = no)	-0.7

Fish Cover (0 = absent, 1 = Present but sparse, 2 = moderate to heavy)	
aquatic weeds	1.9
snags	0.0
brush or woody debris	0.6
inundated live trees	0.0
overhanging vegetation	1.2
rock ledges or sharp dropoffs	0.0
boulders	0.0
human structures	0.5

Questionnaire

CURLEW

Results compiled from 7 **Surveys.** **Average time (years) respondents spent on lake:** 12.43

Did the following add (+1), detract (-1), or have no effect (0) on your enjoyment of the lake today?

Types of WaterCraft:	-0.6	View:	0.8	Distance to Lake:	0.0
Public Access:	0.8	Swim Beach:	0.4	Canada Geese:	-0.4
Water Clarity:	-0.8	Water Qual. for Swim:	-0.6		
Fishing Quality:	0.4	Aquatic Plants:	-0.6		

On a scale of 1 (poor) to 5 (excellent), how would you rate water quality today? **2.1**

Which would you rather have, 1 or 2?

1) Better fishing and more natural habitat, or 2) clearer water?	1.7
1) Better fishing and more natural habitat, or 2) fewer aquatic plants?	1.1
1) Clearer water, or 2) fewer aquatic plants?	1.1

How important is each of the following characteristics to you (1 = very undesirable, 5= very desirable):

Restricted Watercraft:	4.3	Good Warmwtr Fishing:	3.9	Natural Scenery:	4.4
Plant Growth:	2.3	Good Swimming:	3.7	Public Beach:	3.4
Natural Shoreline:	3.4	Less Algae:	4.1	Canada Geese:	2.9
No Odors:	4.3	Public Access:	3.9		
Good Coldwtr Fishing:	4.4	Clear Water:	4.6		

Tabulated Results

Survey ID	Date	Residency		Rent or Own	Primary Activity*	Water Clarity: Purchase Factor?	Water Clarity: Has it Changed?	Water Clarity: When?
91	7/28/1999	Resident	Permanent	Rent	2	☐	Worse	1950
132	8/1/1999	Resident	Permanent	Rent	1	☑	Worse	
166	6/25/1999	Visitor			2	☐	Unknown	
167	6/25/1999	Visitor			2	☐	Unknown	
	The condition of Curlew has been subjected to numerous studies. I would support any and all actions to clean it up.							
168	7/25/1999	Visitor			2	☐	Unknown	
173	6/25/1999	Visitor			10	☐	No	
	Need a 5 mph speed limit until 11am and after 7pm.							
176	6/27/1999	Visitor			10	☐	Unknown	

* 1=canoe/kayak, 2=fish, 3=pers. wtrcrft, 4=mtrboat, 5=sail, 6=swim/wade, 7=watch wldlf, 8=ski, 9=windsurf, 10=relaxing

Zooplankton Report

CURFE1

Date 6/17/1999 Station: 1 Sample ID 61

Less than 1/3 mL sampled. Site not labelled. Probably site 1 (?).

Number of organisms measured: #Delet

Group	Percent	Group	Percent
Cladocera	#Deleted	Small < 1mm	#Deleted
Copepod	#Deleted	Large >= 1mm	#Deleted
Other	#Deleted	Ratio of large to Smal	#Num!
		Average size (mm):	0.69

Date 6/17/1999 Station: 2 Sample ID 78

Dense algae in sample. Less than 0.5mLs counted.

Number of organisms measured: #Delet

Group	Percent	Group	Percent
Cladocera	#Deleted	Small < 1mm	#Deleted
Copepod	#Deleted	Large >= 1mm	#Deleted
Other	#Deleted	Ratio of large to Smal	#Num!
		Average size (mm):	0.58

Date 8/12/1999 Station: 1 Sample ID 51

Number of organisms measured: #Delet

Group	Percent	Group	Percent
Cladocera	#Deleted	Small < 1mm	#Deleted
Copepod	#Deleted	Large >= 1mm	#Deleted
Other	#Deleted	Ratio of large to Smal	#Num!
		Average size (mm):	0.80

Aquatic Plant Data

CURLEW

Sampler: Parsons, O'Neal

Survey Date: 7/28/1999

Max depth of growth (M): 5

Comments Sunny, breezy. Much algae on plants and forming a surface scum in shallow areas. Went around whole lake doing habitat survey, but only closely checked the plants at all the boat launches.

SPECIES LIST

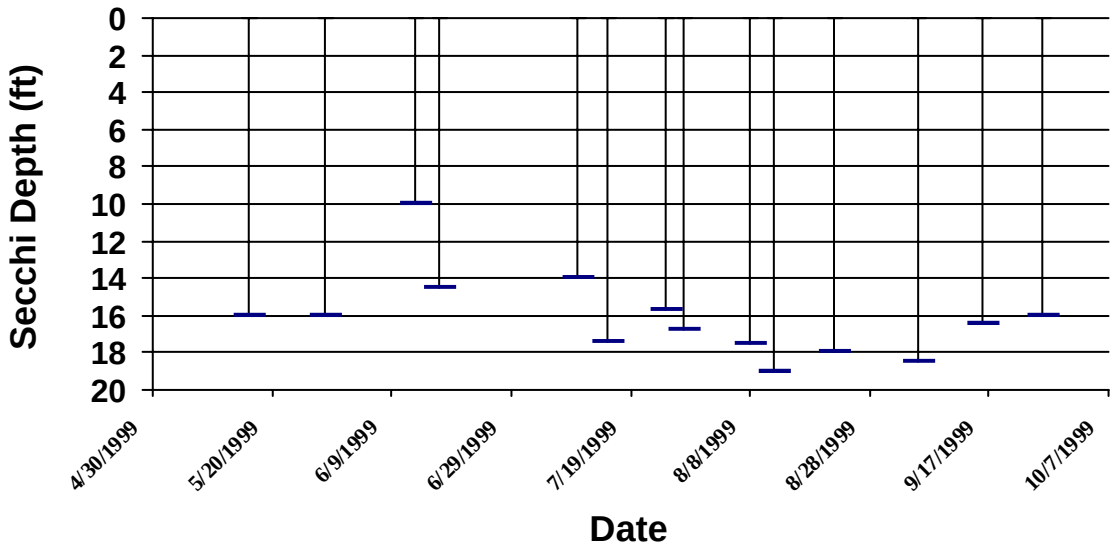
Scientific Name	Common Name	Dist [a]	Comments
Ceratophyllum demersum	Coontail; hornwort	2	
Chara sp.	muskwort	4	dominant in many areas
Elodea canadensis	common elodea	2	
Heteranthera dubia	water star-grass	2	
Lemna minor	duckweed	1	
Myriophyllum sibiricum	northern watermilfoil	2	
Potamogeton crispus	curly leaf pondweed	4	dominant in more disturbed areas
Potamogeton friesii	flat-stalked pondweed	2	
Potamogeton illinoensis	Illinois pondweed	2	
Potamogeton natans	floating leaf pondweed	1	few patches
Potamogeton pectinatus	sago pondweed	2	
Potamogeton praelongus	whitestem pondweed	2	

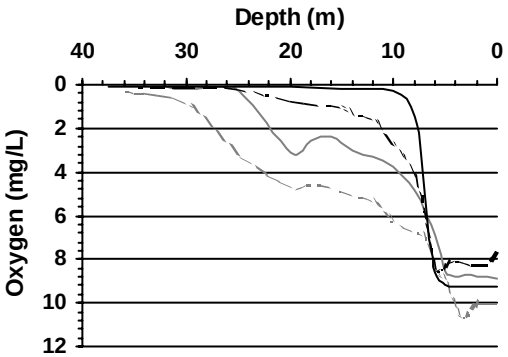
Potamogeton pusillus	slender pondweed	2	may be same as thin leaf
Potamogeton richardsonii	Richardson's pondweed	2	
Potamogeton sp (thin leaved)	thin leaved pondweed	2	may be same as pusilis
Ranunculus aquatilis	water-buttercup	1	

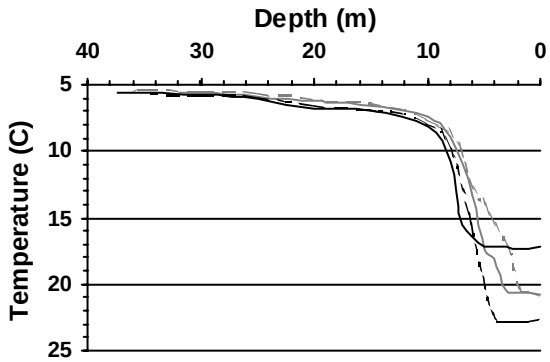
[a] 0 - value not recorded (plant may not be submersed)
1 - few plants in only 1 or a few locations
2 - few plants, but with a wide patchy distribution
3 - plants in large patches, codominant with other plants
4 - plants in nearly monospecific patches, dominant
5 - thick growth covering substrate to exclusion of other species

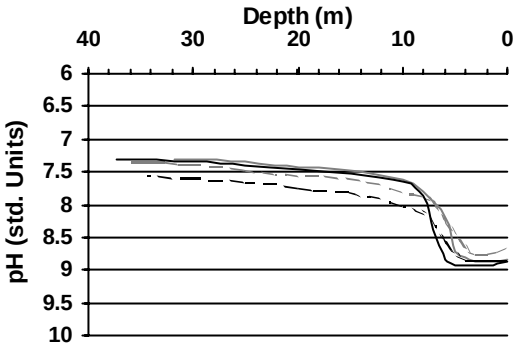
Secchi Depth and Profile Graphics

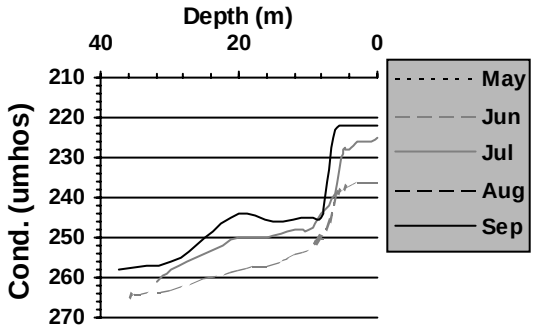
Station: 1 CURFE1











Secchi Data and Field Observations

CURLEW

Date	Time	Temp-erature (F)	Secchi (ft)	Color (1-greens, 11-browns	Bright-ness (pct)	Wind (1-none, 5-gusty)	Rainfall (0-none, 5-heavy)	Aesthetics (1-bad, 5-good)	Swimming (1-poor, 5-good)	Geese (#)	Waterfowl (besides geese #)	Boats-Fishing (#)	Boats-Skiing (#)
Station 1													
5/16/1999		39	16	2	100	2	5	5	5	25	3	7	0
	Sampler:	PERRY		Remarks:	Used a view tube on the second Secchi reading but not on the first. Cloudburst and hail yesterday. Showers most of the week, sprinkling off and on today.								
5/29/1999		44	16	6	0	1	1	4	4	4	8	7	0
	Sampler:	PERRY		Remarks:	Used a view tube on the second Secchi reading but not the first. Lake has floating algae mats. Saw two live "Anadonta californicus" clams today!								
6/13/1999		48	10	6	100	3	1	4	3	6	10	3	0
	Sampler:	PERRY		Remarks:	Used a view tube on the second Secchi reading but not the first Secchi reading. Aesthetic enjoyment affected by floating algae mats. Thermometer not functioning - fluid has separated. Distrust at least the last two readings.								
6/17/1999		68	14.5	6	5	1	1	3	2	15	5	7	
	Sampler:	PERRY		Remarks:									
7/10/1999		69	14	6	0		1	4	3	0	5	12	0
	Sampler:	PERRY		Remarks:	First Secchi reading taken without a view tube, second Secchi reading is with a view tube. Weed mats in shallows. Geese feed here in afternoon - I sample in the morning.								
7/15/1999			17.4	6	60	2	1	4	4	2	20	8	2
	Sampler:	HALLOCK		Remarks:	Bottom: 31.8M. P. crispus appears to be getting worse. Oxygen < 5 @ 8M, ~0 @ 25M. Some zoopl. and no H2S smell, even at 25M								
7/25/1999		68	15.75	6	50	1	2	4	4	0	2	2	0
	Sampler:	PERRY		Remarks:	First Secchi reading without a view tube, second Secchi reading with view tube.								
7/28/1999			16.73										
	Sampler:	Parsons		Remarks:									
8/8/1999		72	17.5	6	100	3	5	3	4	0	2	1	0
	Sampler:	PERRY		Remarks:	First Secchi reading without a view tube, second Secchi reading with a view tube.								
8/12/1999			19	6	90	1	1	4	3	8		6	3
	Sampler:	PERRY		Remarks:	Bottom: 34.5M. Algae specks clearly visible throughout water column. According to volunteer, there didn't used to be nesting geese on the lake, but now are about 50 goslings/year and people are beginning to perceive them as a problem.								
8/22/1999		68	18	6	0	1	1	4	4	0	0	3	0
	Sampler:	PERRY		Remarks:	First Secchi reading without a view tube, second Secchi reading with a view tube.								

Date	Time	Temp-erature (F)	Secchi (ft)	Color (1-greens, 11-browns	Bright-ness (pct)	Wind (1-none, 5-gusty)	Rainfall (0-none, 5-heavy)	Aesthetics (1-bad, 5-good)	Swimming (1-poor, 5-good)	Geese (#)	Waterfowl (besides geese #)	Boats-Fishing (#)	Boats-Skiing (#)
9/5/1999		64	18.5	6	75	2	1	4	4	0	2	4	0
	Sampler: PERRY			Remarks: First Secchi reading without a view tube, second Secchi reading is with a view tube.									
9/16/1999			16.4	3	50	1	1	2	2	12	30	6	
	Sampler: PERRY			Remarks: Bottom: 37.6M. Aphanizomenon bloom moderate to severe. Took zebra mussel veliger sample from state park pier.									
9/26/1999		60	16	6	50	1	1	4	4	4	11	5	0
	Sampler: PERRY			Remarks: First Secchi reading taken without a view tube, second Secchi reading is taken with a view tube. Fewer clumps than last time. Lake height taken one week later than rest of data. One brief rain shower in week. The Conductivity result is qualified as an estimate due to postcalibration failing QA/QC requirements.									
Station 2													
6/17/1999			14										
	Sampler: PERRY			Remarks:									
7/15/1999			17.1	6	35	2	1						
	Sampler: HALLOCK			Remarks: Bottom: 32.5M. Site 2 is just north of Dammann's (now Perry's) island.									
8/12/1999			20.34	6									
	Sampler: PERRY			Remarks: Bottom: 28.2M									
9/16/1999			15.1	3									
	Sampler: PERRY			Remarks: Bottom: 32.2M.									